METHOD FOR FORMING PIEZOELECTRIC/ELECTROSTRICTIVE FILM ELEMENT AT LOW TEMPERATURE USING ELECTROPHORETIC DEPOSITION AND THE FILM ELEMENT FORMED BY THE METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method for forming piezoelectric/electrostrictive film element using an ultrafine ceramic oxide powder and the electrophoretic deposition, and piezoelectric/electrostrictive film element produced by the method. In particular, the present invention relates to a method for forming a piezoelectric/electrostrictive film element at low temperature by way of electrophoretic deposition method using an ultrafine ceramic oxide powder having excellent reactivity and produced by a single process at low temperature, and the piezoelectric/electrostrictive film element produced by the method.

Description of the Prior Art

Unit particle micronization and particle diameter distribution uniformalization etc. are emphasized in ceramic oxide powder which is raw material of various devices using the ceramics such as ink jet head, memory chip, and piezoelectric substance, because in case of finer particles the activation energy can be lowered by surface treatment and the reactivity and applicability can be improved by particle electrification.

So far the method has been used where a ceramic sol controlled of viscosity or a ceramic oxide powder regenerated by a suitable solvent is fixed at the substrate in order to form a

piezoelectric/electrostrictive film element in manufacturing method of various film devices using the ceramics.

Considering ultimately obtained film quality, methods mainly used for the ceramic sol solution are dip coating, spin coating, electrochemical oxidation/reduction etc. while methods used for the ceramic oxide powder are various printing, molding, electrophoretic deposition (EPD) etc.

Among these methods, EPD is a method to mold an elaborate film using the polarization of each component by electric polarity and the stacking property of solid particles.

In the EPD process using a ceramic oxide powder in Figure 2, ceramic particles of average diameter not less than 1 μm made by solid phase process are dispersed in adequate dispersion medium of water or organic dispersant, then they are mixed with a pH-controlling medium to make a sol solution controlled of surface electric charge, which the colloidal suspension is used for ceramic to move to cathode or anode to form a film on substrate which film is vapor deposited by thermal treatment above 1000°C eventually to form the film.

EPD like this has advantage to make a high quality film unrestricted of area or thickness using a simple equipment.

But there needs a separate operation to disperse powder using a dispersant in order to secure dispersibility because large particle diameter powder is used; and there is inevitability problem of high temperature thermal treatment to get material property peculiar of ceramic because formed film property is similar to bulk.

SUMMARY OF THE INVENTION

The present invention to solve the problems has purpose of firstly a method to form a piezoelectric/electrostrictive film element through electrophoretic deposition and thermal treatment at low temperature using ultrafine ceramic oxide powder which is very excellent in reactivity as well as it is very fine in particle size as it has been made by single process at low temperature by combustion method using the citric acid as a combustion aid and of secondly the provision and supply of piezoelectric/electrostrictive film element formed by the method at low temperature.

The present invention to achieve the purpose features a method for forming piezoelectric/electrostrictive film element at low temperature using electrophoretic deposition, the method comprising the steps of : preparing a solution or a dispersed mixture containing constituent ceramic elements by dissolving or dispersing the raw material of constituent ceramic elements in a solvent or a dispersion medium; preparing a mixed solution by adding citric acid into the solution or the dispersed mixture in which the constituent ceramic elements are dissolved or dispersed; getting ultrafine ceramic oxide powder of particle size less than 1 μm with uniform particle diameter size distribution by forming ceramic oxide without scattering over, by nonexplosive oxidative-reductive combustion reaction by thermally treating the mixed solution at 100-500°C; preparing a suspension by dispersing the ultrafine ceramic oxide powder in an organic dispersant; preparing ceramic sol solution by dissolving constituent ceramic elements of same or similar constituent with the ultrafine ceramic oxide powder in water or